HELICAL ROTARY CUTTER AND METHOD

TECHNICAL FIELD

This invention relates to a rotary helical cutter with replaceable straight flat blades. The disclosure incorporates the helical rotary cutter and method disclosed in provisional patent application 60/177,488, filed January 21, 2000, whose priority is claimed for this application.

BACKGROUND OF THE INVENTION

Rotary cutters are employed to cut material passing through extrusion dyes into pellets. For high volume production, one rotary cutter assembly cuts material passing through a number of extrusion passages simultaneously.

Helical cutter blades are preferred to reduce noise, lower vibration and reduce peak loads on the power source. However, helical blades are difficult to manufacture and to sharpen. If the material being cut is relatively rigid, there can be some space between the cutting edges on a driven rotor and the extrusion dye. However, if the material to be cut is somewhat soft, the space between a cutting edge and a dye port must be reduced to near zero to obtain a clean cut.

A rotor for cutting that is currently in use has a plurality of slots that extend the length of the rotor. Each slot extends from one end to the other of the rotor at a slight angle relative to the axis of

rotation to provide a helix angle. Each slot also has a cutter blade base support surface that is in a flat plane extending the length of the rotor. A straight blade is supported on the base support. Due to an hourglass effect, the rotor radius extending from the axis of the rotor to the cutting edge of the blade is substantially larger at both ends of the rotor than it is in the center of the blade. To correct for the hourglass effect a plurality of cutter segments are mounted on each base support. The width, in a radial direction, of each cutter segment is varied to correct for the hourglass effect.

The cutter blades are made from special cutter blade materials. These materials are difficult to shape and sharpen. To form a cutting edge on all the cutter blade segments that are within the required range of accuracy it is necessary to mount a complete set of blades on a rotor, mount the rotor in a machine tool and grind the cutting edges to the required shape and dimensions. A rotary cutter with blade segments that have to be ground after the segments are mounted on the rotor is not repairable in the field. If one blade is damaged it is often necessary to remove the rotor from the machine and send it to the manufacturer for repair or blade sharpening.

SUMMARY OF THE INVENTION

The base support surface of the rotor is machined in base support sections. Each base support section is the length of one of the blades. The ends of each base support section are a fixed radial distance from the axis of rotation of the cutter rotor. Adjacent base support surfaces are in intersecting planes. No two adjacent base support surfaces are in the same plane. Each cutter blade has an hourglass effect. By shortening each blade section and the base support surface, the error due to the hourglass effect is reduced. As the length of each blade section and each base support surface approaches zero, the hourglass effect error also approaches zero.

The base support surfaces are machined starting at one end of the rotor. At the end of each base support surface section, the path of movement of the cutting or grinding tool is changed.

BRIEF DESCRIPTION OF THE DRAWINGS

The presently preferred embodiment of the invention is disclosed in the following description and in the accompanying drawings, wherein:

Figure 1 is a perspective view of the rotor with blades mounted in one groove only;

Figure 2 is an enlarged end view showing the grooves in the rotor with parts broken away;

Figure 3 is a plan view of the rotor without blades;

Figure 4 is a left end view of the rotor taken along line 4-4 in Figure 3;

Figure 5 is a sectional view taken along line 5-5 in Figure 3;

Figure 6 is a sectional view taken along line 6-6 in Figure 3;

Figure 7 is a sectional view taken along line 7-7 in Figure 3;

Figure 8 is a right end view taken along line 8-8 in Figure 3; and

Figure 9 is a schematic showing a relationship of joined base support surfaces relative to each other.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The rotor 10, as shown in Figure 1, is machined from a stainless steel cylinder to form a shaft with an axis of rotation 12. Cylindrical bearing supports 14 are provided on each end. Rotor drive connectors 16 are small diameter projections outboard of the bearing support 14 on both ends of the rotor 10. A drive connector 16 is shown on only one end of the rotor 10 in Figure 1. The rotor 10 is driven in the direction indicated by the arrow 17 in Figure 1.

Grooves 18, shown in Figure 2 are machined into the outer periphery 20 of the rotor 10. These

grooves 18 extend from the left end 22 to the right end 24. Each groove 18 is at an angle Ø to the axis 12 to provide a helix.

The grooves 18 have a leading groove wall 26 and a trailing groove wall 28. A base support surface 30 supports the base 32 of a straight flat blade 34 adjacent to the leading groove wall 26 and each groove 18. A base support surface 36 supports the base 32 of a straight flat blade 34 adjacent to the trailing wall 28 in each groove 18. The groove floor 38 and each groove 18 is spaced radially inward from the base support surfaces 30 and 36. The leading wall 26 of each groove 18 is in a plane that extends from the left end 22 to the right end 24. The trailing wall 28 of each groove 18 is also in a plane that extends from the left end 22 to the right end 24.

The base support surface 30 in each groove 18 extends only from the left end 22 to the section line 5-5 shown in Figure 3. The surface 30 is in a plane and supports a left end section blade 34. A base support surface 40 intersects the surface 30 and extends from the section line 5-5 to the section line 6-6 and supports a section blade 34. A base support surface 42 intersects the surface 40 and extends from the section line 6-6 to the section line 7-7 and supports a section blade 34. A base support surface 44 intersects the surface 42 and extends from the section

line 7-7 to the right end 24 and supports a section blade 34.

The base support surface 36 in each groove 18 extends only from the left end 22 to the section line 5-5 shown in Figure 3. The surface 36 is in a plane and supports a left end section blade 34. A base support surface 46 intersects the surface 36 and extends from the section line 5-5 to the section line 6-6 and supports a section blade 34. A base support surface 48 intersects the surface 46 and extends from the section line 6-6 to the section line 7-7 and supports a section blade 34. A base support surface 50 intersects the surface 48 and extends from the section line 7-7 to the right end 24 and supports a section blade 34.

Figure 9 is a schematic showing the relationship between the planes with the blade support surfaces 30, 40, 42, and 44.

Figures 4-8 shows the location of the starting and ending points of the blade support surfaces 30, 40, 42 and 44 in inches, in a cartesian coordinate system. The rotor 10 in the example shown in Figures 1 and 2 is a metric unit manufactured in a machining center that is programmed in inches. The machining center can also be programmed in a polar coordinate system as well as in metric units. The end

result would be the same regardless of the programming employed by the machining center.

The cutter blades 34 are rectangular member. Each blade 34 has end surfaces 52 and 54, a base surface 32 and a cutting edge 58. Each blade 34 also has a front face 60, a back face 62 and a beveled surface 64.

Two straight flat blades 34 are mounted in each groove 18 in one groove section. One blade 34 has its base 32 on the base support surface 30 and another blade has its base on the base support surface 36. A wedge block 66 is placed between the two blades 34. Bolts 70 pass through bores 68 through the wedge block 66 and screw into threaded bores 72 in the rotor 10. When the bolts 70 are tightened, they urge the wedge block 66 toward the groove floor 38 and the axis of rotation 12, urge one blade 34 toward the base support surface 30 and the leading wall 26 and urge the other blade toward the base support surface 36 and the trailing wall 28. One wedge face 74 of each wedge lock 66 contacts the front face 60 of a blade 34. The other wedge face 80 contacts the back face 62 of a blade 34. The bases 32 of the blades 34 in each groove 18 adjacent to the end 22 as well as to the end 24 are closer together than the bases of the blades on the support surfaces 40 and 46 as well as the support surfaces 42 and 48. The wedge blocks 66 are shaped to

accommodate these differences in spacing. The wedge blocks 66 adjacent to the ends 22 and 24 of the grooves 18 are relatively narrow. The wedge blocks 66 that are midway between the ends 22 and 24 of the grooves 18 are relatively wide.

The rotor 10 as described above has eight blades 34 in each groove 18. There are a total of 16 grooves 18 and one hundred twenty-eight blades 34. All of these blades 34 are identical to each other. As a result the blades 34 can be changed in the field and can also be sharpened in the field. The rotor 10 as described above with blades 34 that are 200 mm long, mounted on a rotor that is 200 mm in diameter and that has a helix angle of 1° has a decreased diameter in the center of the blade 34 of about 0.0015 ten thousandths of an inch. This is generally satisfactory for cutting most materials. The hourglass effect can be decreased further by decreasing the length of the blades 34 and adding additional base support surfaces 30 that fit the blades. The hourglass effect can also be varied by changing the helix angle.

The rotor 10 as described above has groups of four blades that abut each other in an end to end relationship and contact either a leading wall 26 or a trailing wall 28. The rotor 10 can be lengthened or shortened as desired and blades 34 can be added or removed to accommodate the rotor length. The

limitations on the length of the rotor 10 is the strength of the rotor and rotor deflection. The rotor diameter can also be increased or decreased.

The rotor construction disclosed above permits the use of standard blades 34. By using blades with a standard size, a grinder employing the rotor 10 can be repaired in the field using tools that are normally available. The repair to a rotor with a few nicked blades 34 could be completed in a few minutes to a few hours. Replacement of all the blades 34 on a rotor 10 can be completed within a few hours without removing the rotor from the machine. The repair of a rotor 10 with blades that are ground to correct the hourglass effect may take a few weeks or even months.

The blades 34 are made from tungsten carbide or other materials with similar or better wear-resistant properties. When grinding material that is less abrasive, the blades 34 can be made from a material that is somewhat softer than tungsten carbide if reduced blade life is acceptable.

The disclosed embodiment is representative of a presently preferred form of the invention, but is intended to be illustrative rather that definitive thereof. The invention is defined in the claims.